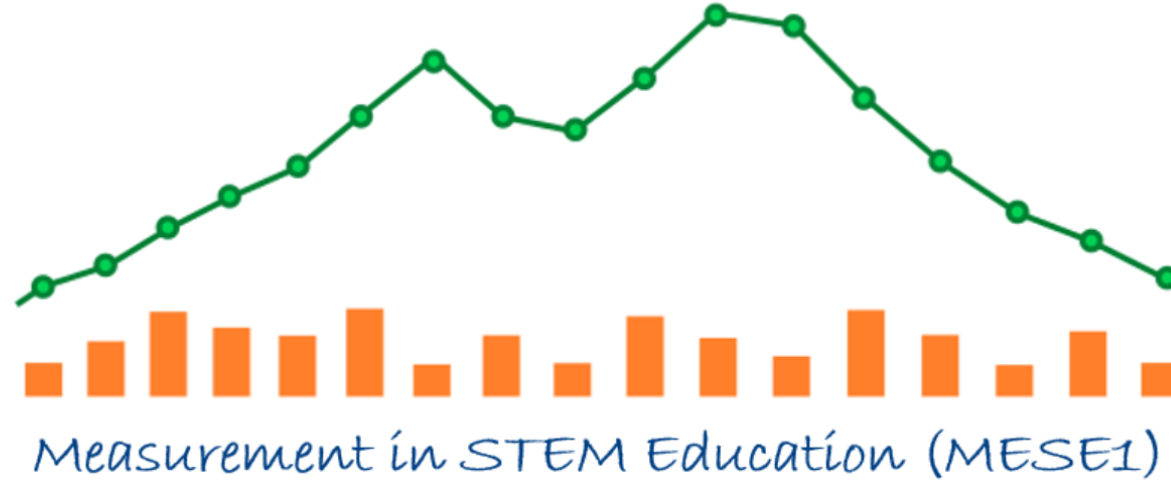# Investigating secondary students' identification with physics through structural equation modeling: a multi group analysis

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Introduction

- Individuals' identities are the results of personal and social negotiations with members of the same community (Gee, 2000).

- There is a large body of research on Physics identity, following the seminal work by Hazari et al. (2010).

- Recently, this framework has been extended to define a more general STEM identity of science undergraduates (Dou & Cian, 2022).

- However, there is still lack of evidence about whether the disciplinary identity construct is useful to discriminate between subjects with different experiences in the specific discipline or who had already chosen an undergraduate course in the discipline.

Aim of the study

Choosing physics as example discipline, we answered to the following research questions:

- Does the physics identity construct differ between physics undergraduates and engineering undergraduates?

- Does the physics identity construct differ between secondary school students who attended extra curriculum activities in physics and other students who did not attend these activities?

- Do gender affect the identity construct? If so, what are the differences between the groups?

Background

- Quantitative studies usually model physics identity as a unidimensional construct which is predicted by interest, recognition and self-efficacy beliefs (Hazari et al., 2010; 2020)

- Moreover, identity development can be influenced other personal identities (e.g. gender) and their personal STEM-related experience (Kim et al., 2018).

- Self-identification with physics, and STEM in general, may greatly differ across different population of students both at high-school and undergraduate level (Grimalt-Alvaro et al., 2021; Dou et al., 2021).

Hypothesized model

Undergraduate: Physics vs. Eng. Enrolment
High-School: enrolment in extracurricular activities on physics vs. generic vocational activities

Interest in physics

Self-Efficacy in physics

Physics identity

Gender

Recognition in physics
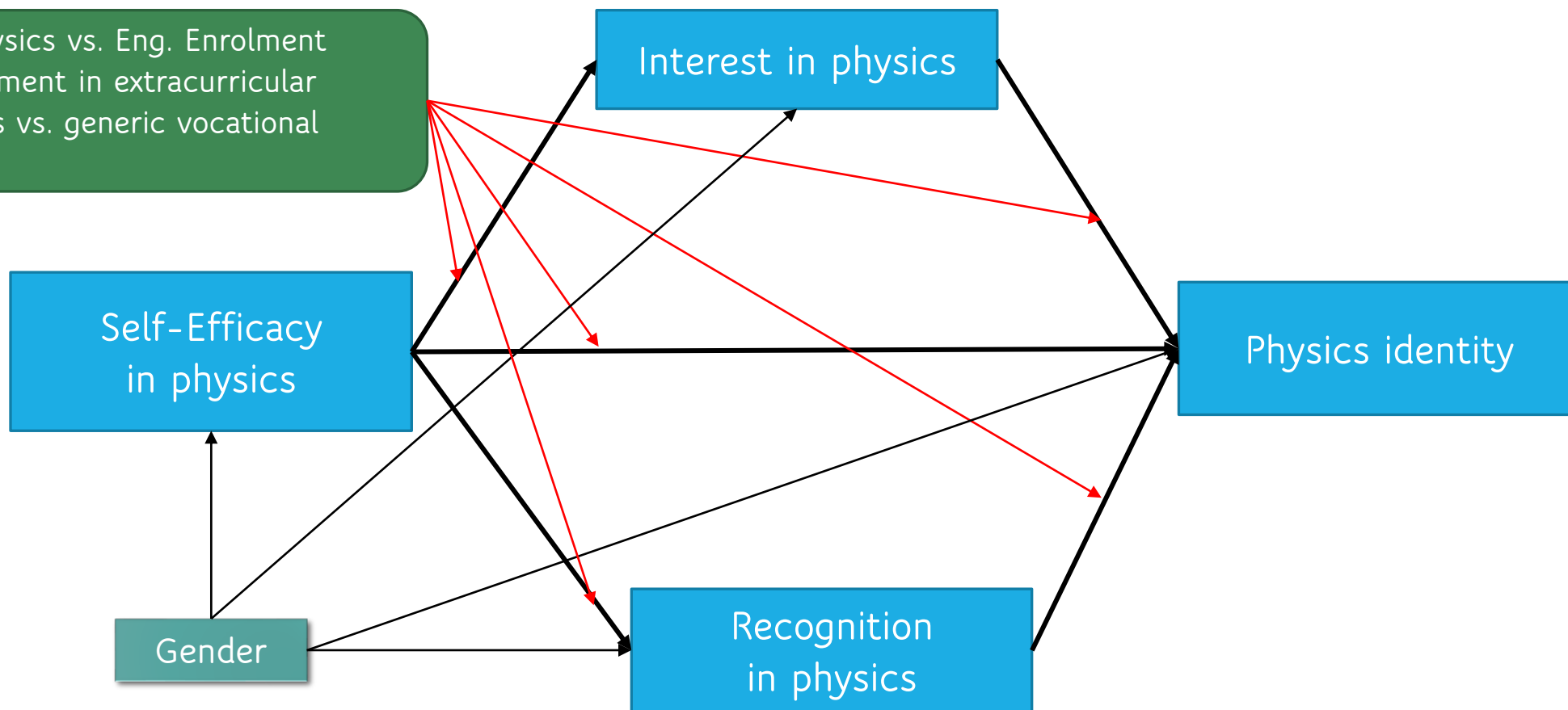
Methods

- **Sample**: N = 1135 Italian students, subdivided in four groups.

  1) Generic vocational activities (N_1 = 169, 48.5% females);

  2) Extracurricular activities on physics (N_2 = 177, 59.9% females);

  3) Freshman Engineering undergraduate (N_3 = 427, 37.5% females);

  4) Freshman Physics undergraduate (N_4 = 362, 36.2% females).

- **Instrument**: 12-items Likert scale survey

- **Data analysis**: Structural Equation Modeling (SEM) applying the maximum likelihood; multigroup analysis using groups as independent variable
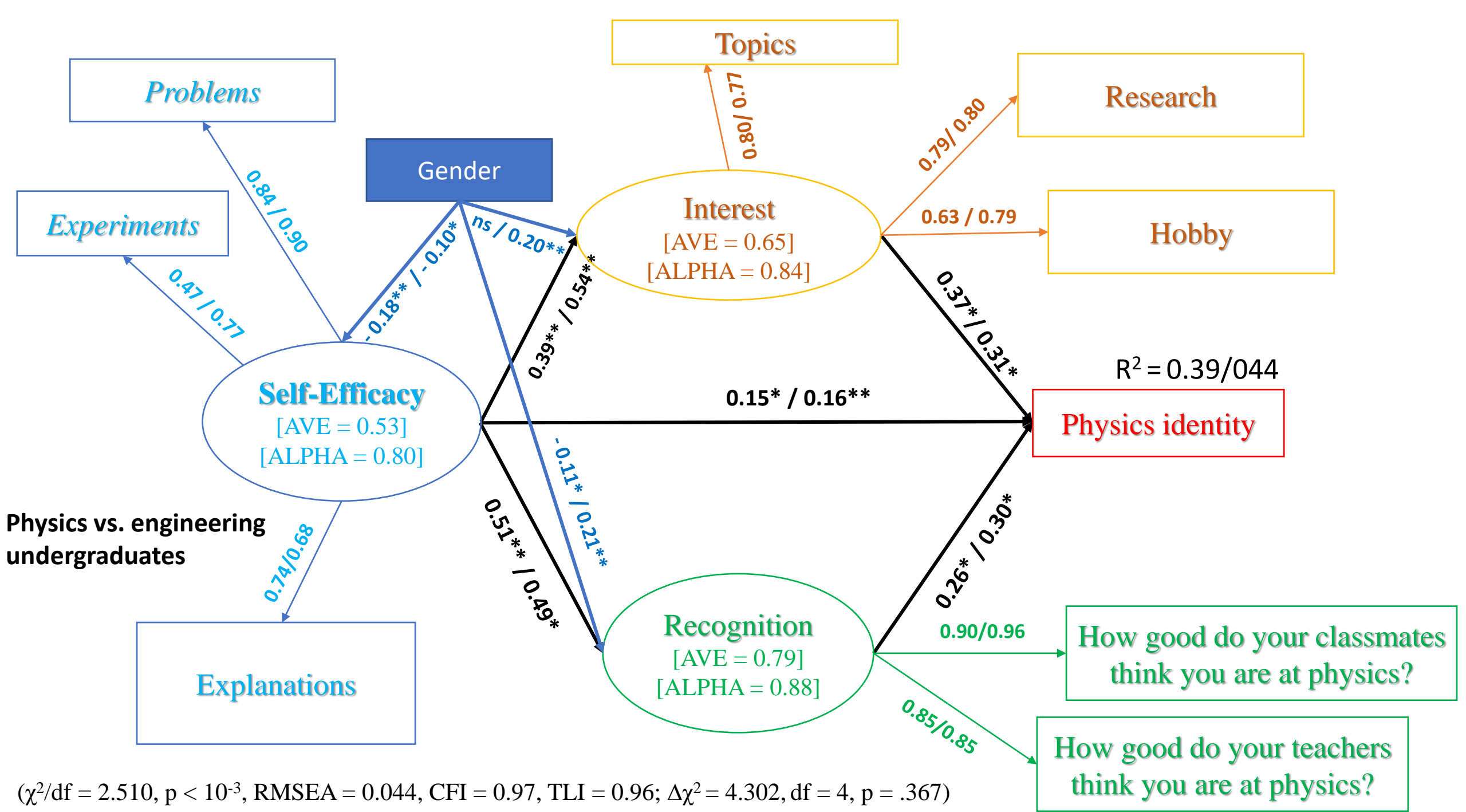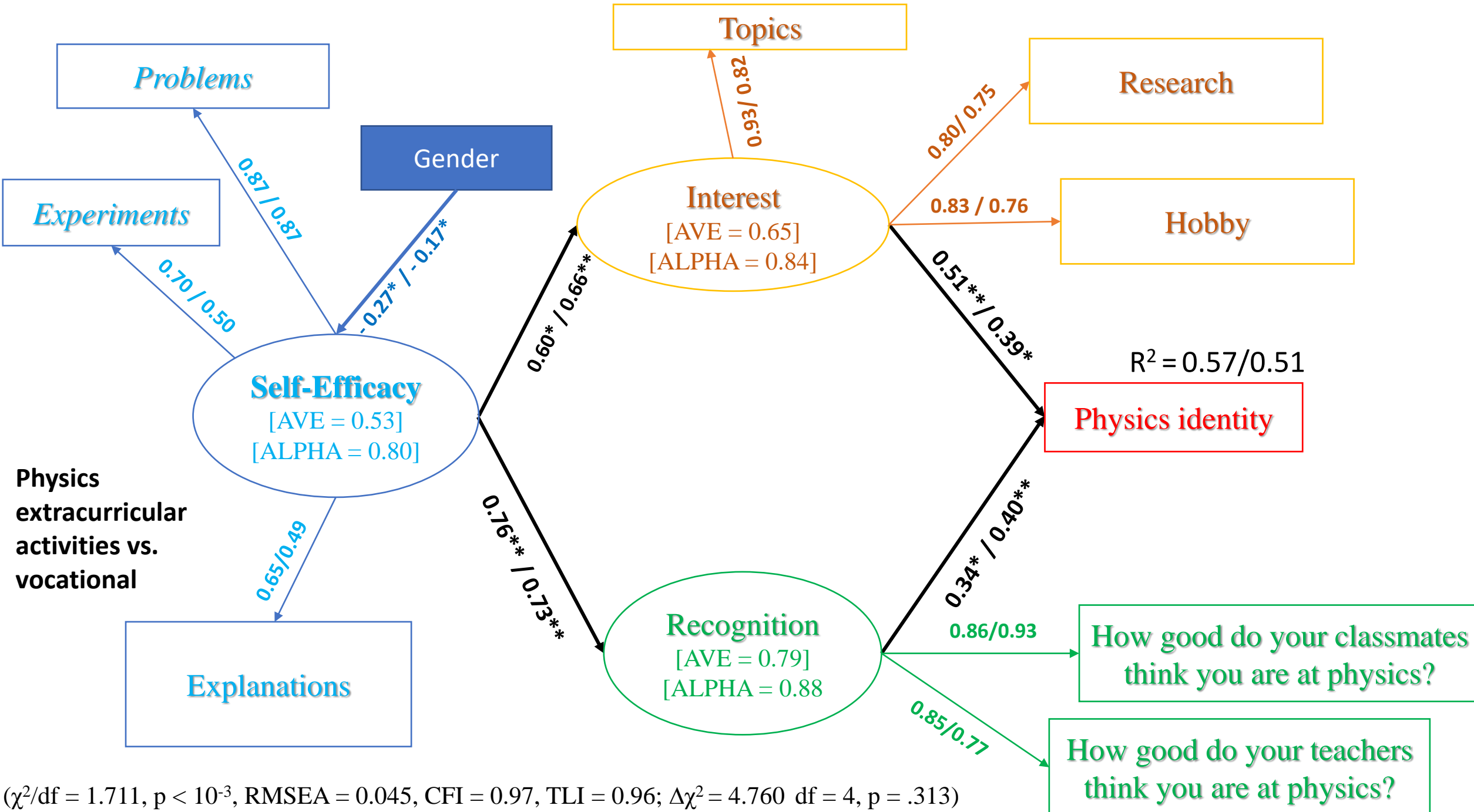
Results

Descriptive statistics
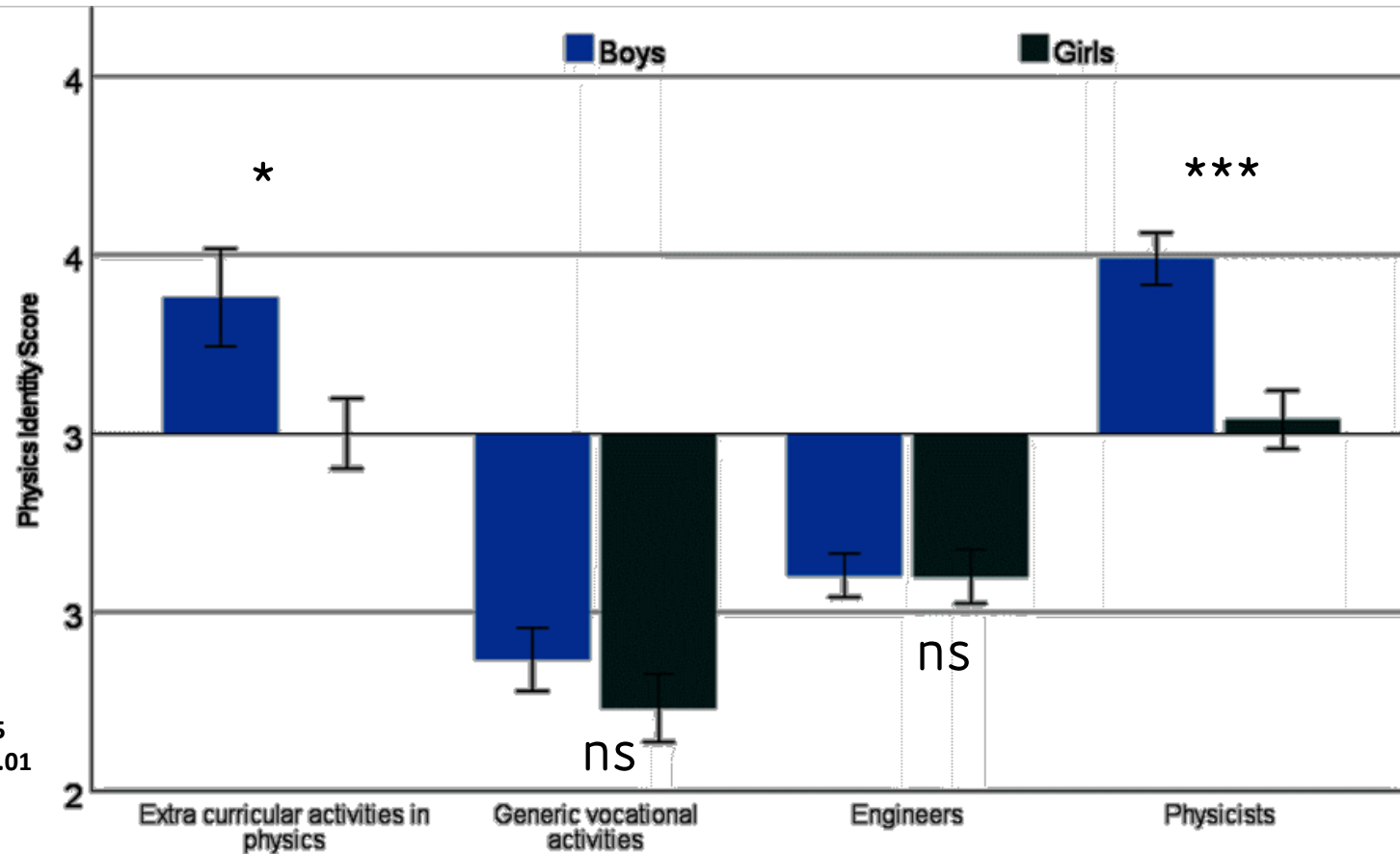
M (SD)		SS	df	MS	F
2.87 (1.09)	Between	174.638	3	58.134	57.134***
	Within	1145,345	1131	1.019	
	Total	1326,983	1134		

ns → p > 0.05,
* → 0.01 < p ≤ **0.05**
** → 0.001 < p ≤ **0.01**
*** → p ≤ **0.001**

Physics vs. engineering undergraduates

$(\chi^2/df = 2.510, p < 10^{-3}, RMSEA = 0.044, CFI = 0.97, TLI = 0.96; \Delta\chi^2 = 4.302, df = 4, p = .367)$

Indirect effects

Path	Physicists	Engineers	Physics Extra-curricular activities	Generic Vocational
Self-efficacy – interest - identity	0.37**	0.28*	0.60**	0.55*
Self-efficacy – recognition – identity	0.34*	0.24*	0.51*	0.62**

Discussion – RQ1

- While the extent to which students identify with physics is significantly different between the physics and engineering students, the structural model for identity is invariant with respect to degree course.

- This results confirms that self-efficacy, interest and recognition predict identity independently on the chosen career path (Dou & Cian, 2022).

- Self efficacy has a direct and indirect effect on identity (Cwik & Singh, 2022)

Discussion – RQ2

- The structural model for identity is invariant with respect to type of activities followed, despite significant differences in the identity score.

- Self-efficacy, interest and recognition predict identity independently on the involvement in physics activities.

- Self efficacy has only an indirect effect on identity, mediated by both interest and recognition.

Discussion – RQ3

- For the physicist's group, gender negatively affects self-efficacy and recognition.

- For the engineering group, gender negatively affects self-efficacy, but it positively affects recognition and interest.

- For all groups, the effect of gender on identity is only indirect.

- For both the extracurricular physics activities group and the generic vocational activities group, gender negatively affects only self-efficacy.

Conclusions

- The identify construct is invariant across different school and university contexts.

- Better sampling approach are needed to confirm the emerged direct and indirect effects.

- Further steps: including other predictors and mediators in the model (e.g., utility value, perceived role of physicists in society) that consider the cultural milieu where identity develops. Longitudinal studies would be needed for this purpose, even though this construct seems to be quite stable over time (Starr et al., 2020).